RESEARCH DEPARTMENT

THE EFFECT OF RECEIVING SITE LOCATION ON RECEPTION OF 90 Mc/s TRANSMISSIONS OVER DISTANCES BETWEEN 100 AND 300 MILES (160 AND 480 km)

Report No. K-105

(1955/28)

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SUMMARY

The report describes some experiments on the effect of site location on the strength and characteristics of v.h.f. signals (90 Mc/s Band) received over great distances.

Short records of field strength were made at each of a number of sites relatively close together in an area distant from the transmitter and simultaneous records were made at the fixed site in the area which had been used previously for long period field strength recording of the Wrotham transmissions. The sites were chosen to sample adequately all types of terrain in the area.

The general conclusions are that the scatter of median values of field at each site in any area tends to diminish as the total distance from the transmitter is increased and that the effect of site height is less important. It is also concluded that v.h.f. fields received at long distance in a built-up area tend to be lower than in the surrounding open country.

1. INTRODUCTION.

During the period 1949 to 1952 measurements were made by the B.B.C. Research Department on v.h.f. transmissions over distances between 100 and 450 miles (160 and 720 km) over land paths. The field level for each particular distance was taken from measurements made at one site only and did not represent the average result taken at a number of different sites at the same nominal distance from the transmitter. These measurements, together with those submitted by the D.S.I.R. and Post Office Engineering Department, were combined to produce curves showing the signal level exceeded for a given percentage of time, plotted against distance from the transmitter. These curves were accepted by a Working Party of C.C.I.R. Study Group V at Stockholm in May 1952 as representative of long distance v.h.f. propagation over land paths and finally recommended for use, with certain reservations, by the VIIth Plenary Assembly of the C.C.I.R. in September 1953.

In plotting the curves, it was assumed that in drawing a smooth line through points which were widely scattered, allowance had been made for the variations caused by the effect of site or location on the values obtained at any one distance and that the final curve thus could be assumed to be that relating to the median (site) values. This assumption had to be made because it had not been possible to set up many recording sites at the same distance from the transmitter at various types of location and with various types of intervening ground profile between the transmitter and receiver.

Since the C.C.I.R. curves attached to Recommendation No. 111 have been and are being used for the purposes of frequency channel allocation planning, it is considered to be most important that further data should be available from which it may be decided under what conditions of distance, location and intervening terrain the C.C.I.R. curves may be found to be either too high or too low. The experiments described in this report were made with the object of supplying such data and of investigating other effects such as fading correlation between neighbouring sites.

During the course of the experiments it was decided also to collect data relating to the maintenance of polarisation over long distances and in various locations. This is a factor pertinent to the planning of co-channel television coverage and is also being considered under C.C.I.R. Question No. 101 of Study Group XI. The results of this investigation are the subject of a separate report.

2. MEASUREMENT TECHNIQUE AND APPARATUS.

Measurements were made at and near the receiving points originally used in the long distance propagation tests from Wrotham, and it was decided to limit the tests to areas where the received signal was expected to be present for most of the time. This resulted in the choice of the three nearest "long distance" sites, i.e. Nottingham, distance 137 miles (221 km); Harrogate, distance 206 miles (330 km) and Newcastle-upon-Tyne, distance 281 miles (453 km). Newcastle subsequently proved to be on the outer limit of continuous signal reception and many days passed when the field was too weak to measure.

The mobile equipment consisted of a long distance field strength recording receiver mounted in a mobile laboratory. The aerial used was a three-element Yagi similar to that employed on the fixed receiving sites and was mounted on the vehicle at a height of 30 ft (9·12 m) above ground level. It was possible to rotate the aerial by remote control from within the vehicle. Where a mains supply was not available, use was made of a petrol electric generator with suitable facilities for stabilising the output voltage.

The procedure was to carry out simultaneous measurements at two sites, one being the receiving point originally used on the long distance propagation experiments, hereafter called the "fixed site", and the other one of a series of locally selected sites, hereafter called the "mobile site", having widely differing characteristics. Measurements were made for a period of a few hours at each of these selected sites and a chart record of the field variation was obtained which could be compared with the similar chart simultaneously recorded at the "fixed site".

The mobile and fixed receivers were first calibrated with the same standard signal generator. The overall calibration of the mobile receiver was then checked against that of the fixed receiver by making a simultaneous recording of the incoming signal on both the receivers with their respective aerials placed as close together as was possible. During this check the mobile aerial was moved slightly to confirm the absence of any local standing wave patterns which might adversely affect the calibration of the aerial and receivers.

Considerable care was taken to maintain the calibration of both the receiver chains and a daily check on the stability of each chain was made.

A chart speed of 12 in. (30·5 cm) per hour was chosen so that the fine structures of the fading could be examined, and a check on synchronisation of the fixed and mobile recorders was made.

When the calibration of the equipment had been completed, the mobile station was moved to one of the selected points and set up.

3. RESULTS.

3.1. Measurements made at Nottingham——Distance 137 miles (221 km).

In this case, the fixed site used a Hallicrafter S-27 receiver. Particular attention was paid to the daily calibration since the gain stability of this receiver was not very good.

Site 1. Dorket Head——the original site used in the long distance propagation measurements from Wrotham 1951–1952. Height above sea level 470 ft (143 m). Ground profile towards Wrotham——Fig. 1.

The mobile equipment was set up within 20 ft (6·1 m) of the fixed site aerial and simultaneous recordings were made of the incoming signal.

The signal had a median value of 1·5 dB above the median value for the site derived from measurements taken over a long period of time during 1951–1952. All further references in this report to the "normal" median value refer to this median value over a long period of time.

Though the input–output law of the two receiving chains differed because of the dissimilar receivers used, examination of the records showed remarkably similar signal patterns.

Site 2A. Bulcote Farm——distance from fixed site approximately 4¼ miles (6·8 km). Height above sea level 70 ft (21·3 m). Ground profile towards Wrotham——Fig. 1.

Here the site was low down in the Trent Valley facing a 200 ft (61 m) ridge at a distance of approximately 2 miles (3·25 km). The site was free from obstructions.

The signal at the fixed site had a median value of 10 dB below normal, with deep fading at a rate of one-half to two minutes.

There was a similarity between the general fading pattern of the two signals but the details of the fine structure were quite different, the fading rate at the mobile site being rather faster.

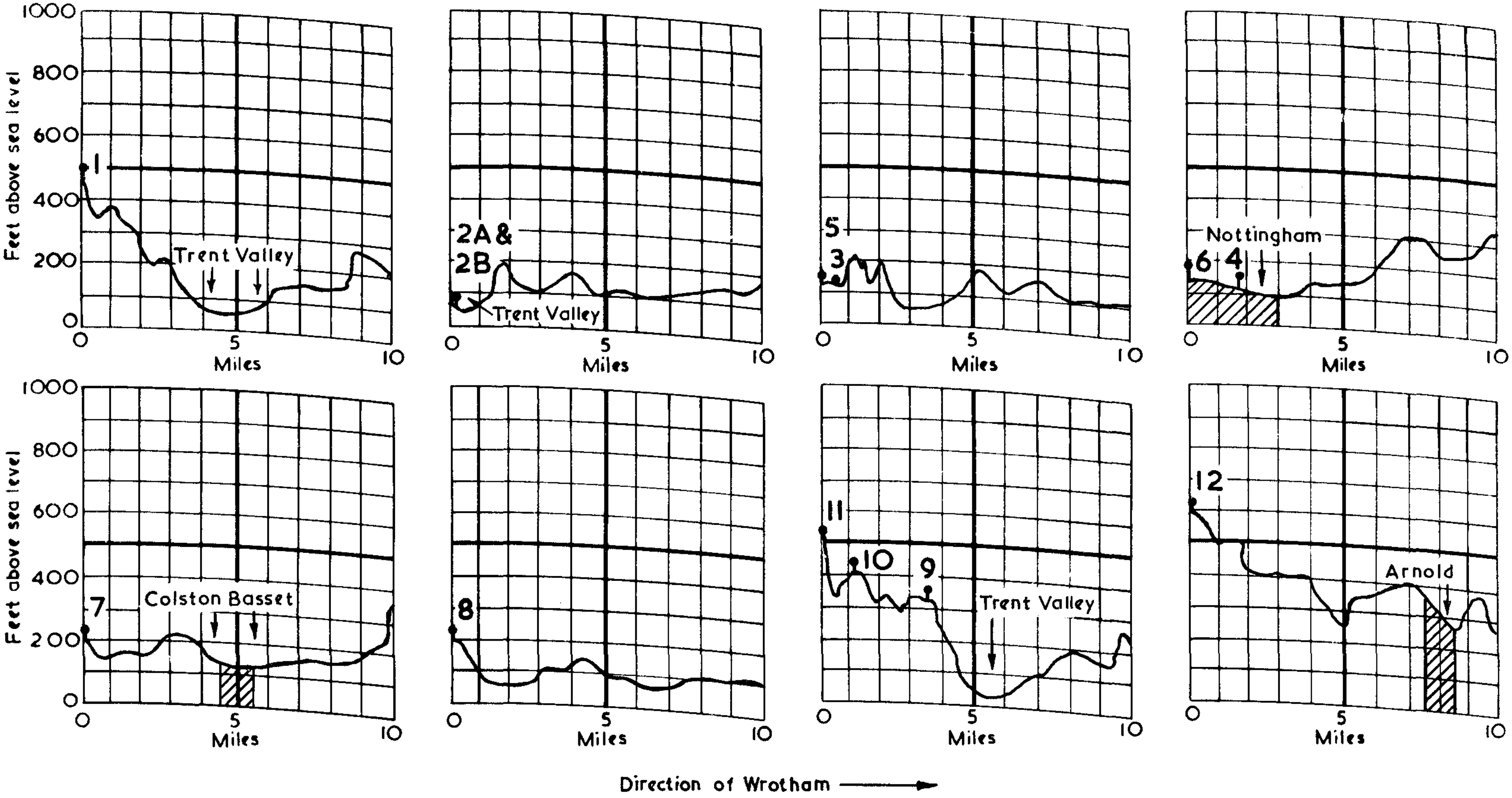

Fig. 1 - Ground profiles towards Wrotham in vicinity of receiving sites
Nottingham area

The numbers refer to the sites,
details of which are given in Table 1

Site 2B. Bulcote Farm——distance from fixed site approximately 4¼ miles (6·8 km). Height above sea level 60 ft (18·2 m). Ground profile towards Wrotham——Fig. 1.

The site position was similar to that of site 2A but at a slightly lower height above sea level, and was 200 yards (182 m) nearer the 200 ft (61 m) ridge.

The median value of the signal at the fixed site was 15 dB above normal.

The signal received at the fixed site was strong and very steady throughout the recording period (75 minutes), whilst the mobile site showed marked variations of field strength, including deep fades.

Site 3. Epperstone By-pass——distance from fixed site approximately 3¼ miles (5·2 km). Height above sea level 110 ft (33·5 m). Ground profile towards Wrotham——Fig. 1.

This site was on a main road carrying little traffic at the time of the tests. There were trees and telephone lines nearby whilst the site faced rising ground up to a 230 ft (70 m) ridge at a distance of half a mile (0·8 km).

The signal at the fixed site had a median value of 17 dB below normal, with deep, rapid fading at a rate of three to five per minute.

There was a similarity between the general signal patterns of the two recordings.

Site 4. Trent Bridge——distance from fixed site approximately 6½ miles (10·4 km). Height above sea level 115 ft (35 m). Ground profile towards Wrotham——Fig. 1.

The site was on flat ground in the S.E. suburbs of Nottingham with an unobstructed path of 150 yards (137 m) on the Wrotham bearing.

The median value of signal at the fixed site was 14·5 dB below normal.

Signals having a fading period of from 0·5 to 2 minutes were received at both sites, with a general similarity of pattern.

There was a marked increase in fast fading and fine texture variations in the case of the mobile site, which was no doubt due to scatter from the numerous reflecting surfaces in the vicinity of the site.

Site 5. Epperstone Road——distance from fixed site approximately 3 miles (4·8 km). Height above sea level 120 ft (36·5 m). Ground profile towards Wrotham——Fig. 1.

The site is just off a road with telephone wires and trees in the vicinity, and faces a 200 ft (61 m) ridge at a distance of about 1 mile (1·6 km).

The median value of the signal at the fixed site was 20 dB above normal.

The signal received was strong, with slow fading. There was a general similarity in fading patterns between the two recordings.

Site 6. Technical College, near the centre of Nottingham——distance from fixed site approximately 5½ miles (8·9 km). Height above sea level 150 ft (45·5 m). Ground profile towards Wrotham——Fig. 1.

This site was in a heavily built-up area on fairly flat ground sloping slightly down in the direction of Wrotham.

The median value of the signal at the fixed site was 12 dB below normal.

The signal received was fading deeply at a rate of three to ten per minute and was more than 10 dB lower than at sites having comparable height and position in rural areas (see Table 1). There was evidence of much more fading at the mobile site than at the fixed site, due no doubt to multiple reflections from nearby buildings.

Site 7. Malkinhill Farm——distance from fixed site approximately 5½ miles (8·9 km). Height above sea level 190 ft (58 m). Ground profile towards Wrotham——Fig. 1.

The site stood on ground first sloping away towards Wrotham and then rising up to 200 ft (61 m) after a distance of 2½ miles (4 km).

The median value of the signal at the fixed site was 8 dB below normal.

The received signal comprised small variations superimposed on a signal showing much slower variations. There was a similarity in the general pattern of the two recordings.

Site 8. Thurgarton Farm——distance from fixed site approximately 6 miles (9·7 km). Height above sea level 200 ft (61 m). Ground profile towards Wrotham——Fig. 1.

The site stood on ground free from obstructions, sloping away for 2¾ miles (4·4 km) whereafter it climbed up to a height of 140 ft (42·5 m).

The median value of the signal at the fixed site was 9 dB above normal.

There was extensive fog during these measurements and the received signal was strong and steady. The signal at the fixed site showed a fade of 20 dB in approximately 5 minutes, though this was not recorded at the mobile site.

This is an interesting example which indicates that at a height of 200 ft (61 m) above sea level the received signal was steadier and stronger than at a height of 420 ft (128 m) above sea level. Reflections from a tropospheric layer at a critical height could have accounted for this.

Site 9. Lambley Lane——distance from fixed site approximately 2½ miles (4 km). Height above sea level 300 ft (91 m). Ground profile towards Wrotham——Fig. 1.

The site stood near the edge of a 300 ft (91 m) ridge overlooking the Trent Valley and was free from obstructions.

The median value of the signal at the fixed site was 5 dB above normal.

Slowly fading strong signals were received at both fixed and mobile sites with a general agreement in signal pattern.

Site 10. South Arnold Lodge—distance from fixed site approximately ¾ mile (1·2 km). Height above sea level 415 ft (126 m). Ground profile towards Wrotham—Fig. 1.

The site was on high ground free from obstructions, sloping down towards the Trent Valley.

The median value of the signal at the fixed site was 7·5 dB above normal.

Strong, steady signals were received at both fixed and mobile sites. There was s similarity between the general fading patterns of the two recordings.

Site 11. Ramsdale Hill—distance from fixed site approximately 1 mile (1·6 km). Height above sea level 510 ft (155 m). Ground profile towards Wrotham—Fig. 1.

The site stood on a hill top looking across the Trent Valley.

The median value of the signal at the fixed site was 0·5 dB below normal.

Signals with slow, deep fades were received at both fixed and mobile sites but there was no correlation between individual fades.

Site 12. Windmill Hill—distance from fixed site approximately 8 miles (13 km). Height above sea level 620 ft (188 m). Ground profile towards Wrotham—Fig. 1.

This site, free from obstructions, stood on high ground sloping down towards Wrotham for at least ten miles (16·1 km); it was the highest of all the mobile sites tested during the Nottingham measurements.

The median value of signal at the fixed site was 13·5 dB above normal.

Strong signals with small variations were received at both the fixed and mobile sites. There was a similarity between the variations of signal on both records.

The results of these measurements are collated in Table 1.

3.2. Measurements made at Harrogate—Distance 206 miles (330 km).

In this case, the two receiving chains were of the same type, making comparison of records more straightforward. The measuring procedure was the same as at Nottingham, with daily checking of receiver calibration.

Site 13. Pannal Ash—the original site used in the long distance propagation measurements from Wrotham 1951-1952. Height above sea level 512 ft (156 m). Ground profile towards Wrotham—Fig. 2.

The mobile equipment was set up within 20 ft (6·1 m) of the fixed site aerial and simultaneous recordings were made of the incoming signals.

RESULTS OF MEASUREMENTS MADE AT NOTTINGHAM

For Ground Profile——See Fig. 1

Site No.	Location of Site	Distance from Fixed Site		Height a.s.l.		Site Details	Ratio in dB of Median Signal Level at Fixed Site relative to Normal* Median Level	Ratio in dB of Median Signal Level at Mobile Site to Median Level at Fixed Site	Ratio in dB of Q.P.** Signal Level at Mobile Site to Q.P. Level at Fixed Site	Comparison of Fixed and Mobile Records
		Miles	km	ft	m					
1	Dorket Head	0	0	470	14·3	Within 20 ft (6·1 m) of fixed site aerial	+ 1·5	0	0	Identical fading period 5–20 minutes
2A	Bulcote Farm	4¼	6·8	70	21·3	Rural	– 10	– 10	– 10·5	General similarity. Fading period 0·5–2 minutes. Evidence of more rapid fading at mobile site.
2B	Bulcote Farm	4¼	6·8	60	18·2	Rural	+ 15	– 14	– 15	Very strong steady signals at fixed site. Very strong signals at mobile site with deep fades.
3	Epperstone By-pass	3¼	5·2	110	33·5	Rural	– 17	– 14·5	– 13·5	General similarity of signal patterns. Fading period 0·2–4 minutes.
4	Trent Bridge	6½	10·4	115	35	Built-up in suburbs	– 14·5	– 14·5	– 14·0	General similarity in signal patterns. Fading period 0·2–2 minutes. Faster fading on mobile site.
5	Grass Triangle, Epperstone Rd.	3	4·8	120	36·5	Rural	+ 20	– 14	– 13	General similarity of signal pattern. Very strong, steady signals at both sites.
6	Technical College	5½	8·9	150	45·5	Heavily built-up in town centre	– 12	– 23·5	– 22·5	Fixed site: fading period 0·1–0·5 minutes. Mobile site: fading period < 0·1–0·1 minutes. Evidence of more fading at mobile site.
7	Malkinhill Farm	5½	8·9	190	58	Rural	– 8	0	+ 2	General similarity of signal pattern. Fading period 1–10 minutes. Slow, deep fades.
8	Thurgarton Farm	6	9·7	200	61	Rural	+ 9	+ 3·5	+ 5	Strong steady signals due to heavy fog. No individual correlation of fades.
9	Lambley Lane	2½	4	300	91	Rural	+ 5	– 1·5	– 0·5	Strong, slowly fading signal. General similarity of signal patterns.
10	S. Arnold Lodge	¾	1·2	415	126	Rural	+ 7·5	+ 2·5	+ 2·5	Strong, steady signals. No correlation between individual fades.
11	Ramsdale Hill	1	1·6	510	155	Rural	– 0·5	+ 4·5	+ 5·5	Slow, deeply fading signal. Fading rate 2–20 minutes. Marked similarity of signal patterns. No correlation between individual fades.
12	Windmill Hill	8	13	620	188	Rural	+ 13·5	+ 3·0	+ 7·5	Very strong, steady signals at both sites.

*Normal signal level refers to average median level measured at site during V.H.F. propagation measurements 1951–1952.

**Quasi-peak values——the value of the signal strength exceeded for 5% of the overall time of the observations.

The median value of the signal received was 1·3 dB above normal.

The received signals were fading deeply with identical patterns on both the fixed and mobile recordings.

Site 14. North Deighton——distance from fixed site approximately 6½ miles (10·5 km). Height above sea level 90 ft (27·5 m). Ground profile towards Wrotham——Fig. 2.

The site was on substantially level ground, free from obstructions.

The median value of signal at the fixed site was 7 dB below normal, with rapid fading.

There was a general similarity in fading pattern between the two recordings, though the mobile site had less fine variations than the fixed site.

Site 15. Sewage Works——distance from fixed site approximately 5 miles (8 km). Height above sea level 175 ft (53 m). Ground profile towards Wrotham——Fig. 2.

The ground around the site was free from trees, buildings and telephone wires.

The median value of the signal at the fixed site was 14 dB above normal.

The fading was deep with a variation rate of from 0·1 to 1 minute. There was a general similarity between the fading patterns of the fixed and mobile recordings.

Site 16. Haggs Bridge——distance from fixed site approximately 4 miles (6·4 km). Height above sea level 200 ft (61 m). Ground profile towards Wrotham——Fig. 2.

The site was in a field, free of trees in the immediate vicinity.

The median value of the signal at the fixed site was 6·5 dB below normal.

The fading was deep with a variation rate of approximately half to two minutes. The two signals were similar as regards general pattern though there was no correlation between the fine texture variations.

Site 17. Spa Bottom Farm——distance from fixed site approximately 2½ miles (4 km). Height above sea level 315 ft (96 m). Ground profile towards Wrotham——Fig. 2.

Situated in a field free of trees, on land sloping away towards Wrotham.

The median value of the signal at the fixed site was 7 dB below normal.

The fading was deep with rapid variations once every two or three seconds. There was a similarity in the envelope pattern of the fixed and mobile recordings, though the fine variations were quite different.

Site 18. The Ridge——distance from fixed site approximately 2 miles (3·2 km). Height above sea level 400 ft (122 m). Ground profile towards Wrotham——Fig. 2.

The site was situated on the side of a road carrying light traffic. There were trees nearby though not on the direct bearing to Wrotham.

The median value of the signal at the fixed site was 9 dB below normal.

The fading was deep with rapid variations, once every two or three seconds. There was a similarity between the envelope patterns of the fixed and mobile recordings with a marked correlation between individual fades at one point of the record. Elsewhere the fine texture variations were quite different.

Site 19. Leyfield House—distance from fixed site approximately 2 miles (3·2 km). Height above sea level 430 ft (131 m). Ground profile towards Wrotham—Fig. 2.

The site was in a valley with trees in the vicinity of the aerial and was generally considered a poor position for reception.

The median value of the signal at the fixed site was 6·5 dB below normal.

At the fixed site the fading was deep with a variation rate of approximately one-half to one minute.

The signal strength received at the mobile site was in the form of isolated bursts; it was very weak and could hardly be measured.

Site 20. Moor Hill—distance from fixed site approximately 2 miles (3·2 km). Height above sea level 600 ft (182 m). Ground profile towards Wrotham—Fig. 2.

Situated by the side of a road carrying light traffic, the site was free from trees or obstructions on the Wrotham bearing.

The median value of the signal at the fixed site was 15 dB above normal.

The fading was deep with a variation rate of approximately one to four minutes. The general patterns of the two recordings were similar but there was no correlation between individual fades.

Site 21. Crimple Head Farm—distance from fixed site approximately 2¼ miles (3·6 km). Height above sea level 700 ft (213 m). Ground profile towards Wrotham—Fig. 2.

This site was free from trees and obstructions on the Wrotham bearing.

The median value of the signal at the fixed site was 3·5 dB above normal.

The fading was deep with a variation rate of approximately one-half to two minutes. There was also present a rapid variation once every few seconds. Both the fixed and mobile recordings showed this general pattern though there was no correlation between individual fades.

Site 22. Briscoerigg Farm—distance from fixed site approximately 2¾ miles (4·4 km). Height above sea level 730 ft (222 m). Ground profile towards Wrotham—Fig. 2.

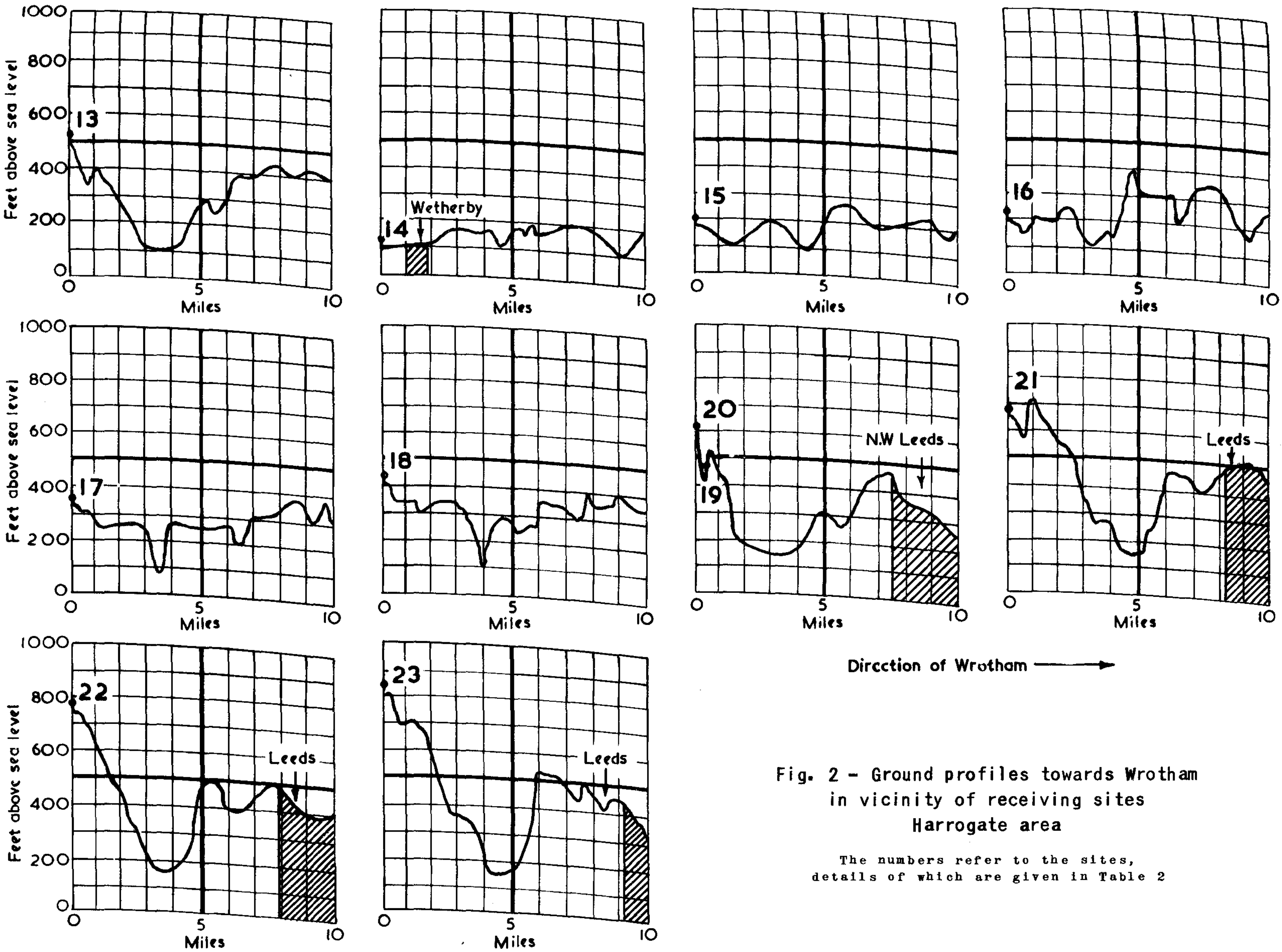

Fig. 2 - Ground profiles towards Wrotham in vicinity of receiving sites Harrogate area

The numbers refer to the sites, details of which are given in Table 2

This site was situated near a road carrying light traffic and was free from trees and obstructions on the Wrotham bearing.

The median value of the signal at the fixed site was 4 dB above normal.

The fading was deep with a variation rate of one-half to three minutes. There was also present a component varying at the rate of once every few seconds. Both the fixed site and mobile site recordings showed this feature, though there was no correlation between the individual fades.

Site 23. Little Arms Cliff—distance from fixed site approximately 3½ miles (5·6 km). Height above sea level 800 ft (243 m). Ground profile towards Wrotham—Fig. 2.

This site was situated just behind the top of a hill, making the actual height of the aerial 25 ft (7·6 m) above the summit. There were no trees or obstructions on the Wrotham bearing.

The median value of the signal at the fixed site was 2 dB above normal.

The fading was deep with a variation rate of one-half to two minutes. There was a similarity between the general patterns of the two recordings though no correlation was evident between the individual fades.

The results of these measurements are given in Table 2.

3.3. Measurements made at Newcastle—Distance 281 miles (453 km).

As at Harrogate, the two receiving chains were of the same type, making comparison of records straightforward. The measuring procedure was the same, with daily checking of receiver calibrations.

Site 24. Heddon Laws—the original site used in the long distance propagation measurements from Wrotham 1951–1952. Height above sea level 480 ft (146 m). Ground profile towards Wrotham—Fig. 3.

The mobile equipment was set up within 50 ft (15·2 m) of the fixed site aerial and simultaneous recordings were made of the incoming signals.

The median value of the signals received was 1 dB above normal.

The signals received were fading at the rate of five or ten times every minute and the fixed and mobile site recordings were identical.

Site 25. Throckley Colliery—distance from fixed site approximately 2½ miles (4 km). Height above sea level 20 ft (6·1 m). Ground profile towards Wrotham—Fig. 3.

This site, situated low down in the Tyne Valley, was on open ground free of obstructions for about 200 ft (61 m) along the Wrotham bearing and was considered a bad site for v.h.f. reception.

TABLE 2

RESULTS OF MEASUREMENTS MADE AT HARROGATE

For Ground Profile——See Fig. 2

Site No.	Location of Site	Distance from Fixed Site		Height a.s.l.		Site Details	Ratio in dB of Median Signal Level at Fixed Site relative to Normal* Median Level	Ratio in dB of Median Signal Level at Mobile Site to Median Level at Fixed Site	Ratio in dB of Q.P.** Signal Level at Mobile Site to Q.P. Level at Fixed Site	Comparison of Fixed and Mobile Records
		Miles	km	ft	m					
13	Pannal Ash	0	0	512	156	Within 20 ft (6·1 m) of fixed site aerial	+ 1·3	0	0	Identical records. Fading period 0·1–1 minute.
14	North Deighton	6½	10·5	90	27·5	Rural	– 7	– 1	+ 0·5	General similarity of signal patterns. Rapid fading on slower envelope. Envelope variations 0·5–1 minute.
15	Sewage Works	5	8	175	53	Rural	+ 14	– 3·5	0	General similarity of signal patterns. Fading period 0·1–1 minute.
16	Haggs Bridge	4	6·4	200	61	Rural	– 6·5	– 3	– 3	General similarity of signal patterns. Fading period ½–2 minutes.
17	Spa Bottom Farm	2½	4	315	96	Rural	– 7	– 2	– 6	Similarity in fading pattern. Rapid fading on slower envelope.
18	The Ridge	2	3·2	400	122	Rural	– 9	0	– 3	Similarity in fading patterns. Rapid fading on slower envelope. Evidence of correlation between individual fades.
19	Leyfield House	2	3·2	430	131	Rural	– 6·5	> – 20	– 13·5	Fixed site: fading rate 0·5–1 minute. Mobile site: very weak signal, isolated bursts only.
20	Moor Hill	2	3·2	600	182	Rural	+ 15	0	+ 4	Similarity of signal patterns. Fading rate 1–4 minutes. Deep fades. No correlation between individual fades.
21	Crimple Head Farm	2¼	3·6	700	213	Rural	+ 3·5	– 1	– 3	General similarity of signal patterns. Fading rate 0·5–2 minutes.
22	Briscoerigg Farm	2¾	4·4	730	222	Rural	+ 4	– 2·5	+ 2·5	Similarity of signal patterns. Fading rate 0·5–3 minutes. No correlation between individual fades.
23	Little Arms Cliff	3½	5·6	800	243	Rural	+ 2	– 1·5	– 1	Similarity of signal patterns. Fading rate 0·5–2 minutes.

*Normal signal level refers to average median level measured at site during V.H.F. propagation measurements 1951–1952.

**Quasi-peak values——the value of the signal strength exceeded for 5% of the overall time of the observations.

The median value of signal at the fixed site was 5·5 dB above normal, with rapid fading.

There was no similarity between the signal patterns of the fixed and mobile recordings. The fixed site signal fading period was 0·2 to 0·5 minutes while the mobile site signal pattern was in the form of long, isolated bursts.

Site 26. South Farm, Throckley——distance from fixed site approximately 2 miles (3·2 km). Height above sea level 180 ft (55 m). Ground profile towards Wrotham——Fig. 3.

The site was free from obstructions along the Wrotham bearing.

The median value of signal at the fixed site was 0·5 dB below normal with a fading rate of 0·5 to two minutes.

There was a general similarity between the patterns of the fixed and mobile sites, though no correlation between individual fades.

Site 27. Worth Farm, Throckley——distance from fixed site approximately 1½ miles (2·4 km). Height above sea level 300 ft (91 m). Ground profile towards Wrotham——Fig. 3.

The site was on open ground, free from obstructions along the Wrotham bearing.

The median value of the signal at the fixed site was 5 dB above normal with very rapid fading superimposed on a slow fading component.

There was a general similarity between the signal patterns of the fixed and mobile recordings, though no correlation between individual fades.

Site 28. Charlton Hill——distance from fixed site approximately 1½ miles (2·4 km). Height above sea level 420 ft (128 m). Ground profile towards Wrotham——Fig. 3.

This site lay within 300 ft (91 m) of a main road with no obstructions close by.

The median value of the signal at the fixed site was 5 dB below normal with very rapid fading superimposed on a slow fading component.

There was a similarity between the slow fading characteristics of both fixed and mobile recordings.

Site 29. Bucks Nook Lane——distance from fixed site approximately 5 miles (8 km). Height above sea level 625 ft (190 m). Ground profile towards Wrotham——Fig. 3.

The site was placed just in the shadow of a hill-top making the aerial 45 ft (13·6 m) below the summit. There were no trees or obstructions on the land up to the hill-top.

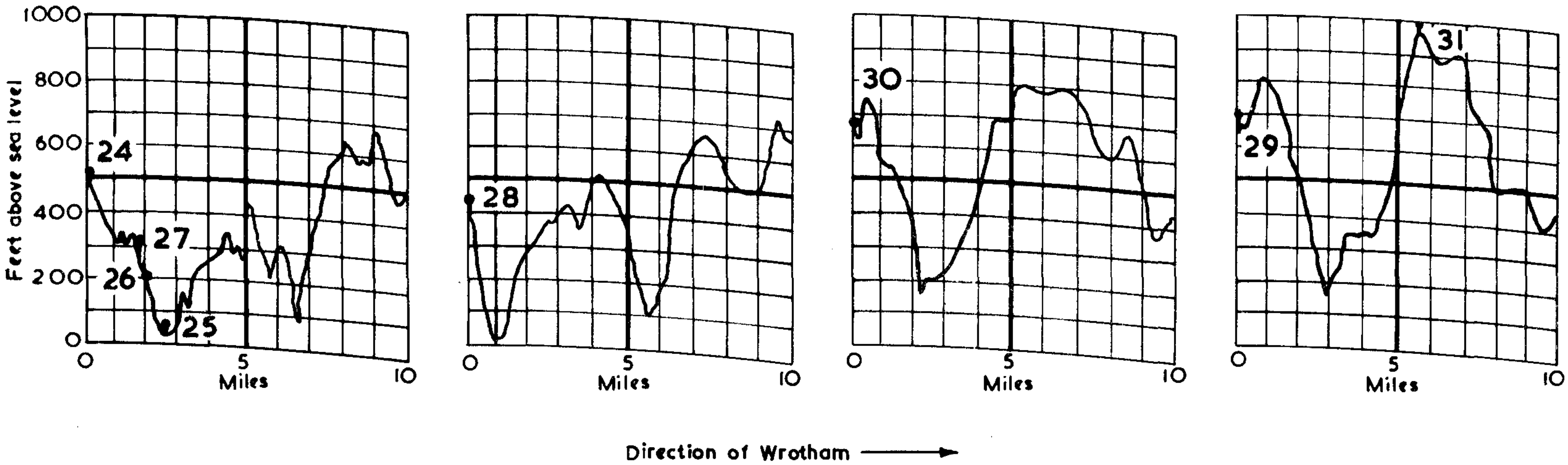

Fig. 3 - Ground profiles towards Wrotham in vicinity of receiving sites
Newcastle area

The numbers refer to the sites,
details of which are given in Table 3

The median value of the signal at the fixed site was 3 dB below normal with a fading rate of one to five fades per minute.

There was no similarity between the signal patterns of the fixed and mobile recordings, the signal at the latter being in the form of long, isolated bursts.

Site 30. Goose Green—distance from fixed site approximately 5 miles (8 km). Height above sea level 650 ft (198 m). Ground profile towards Wrotham—Fig. 3.

The site was in the shadow of high ground at a distance of ½ mile (0·8 km), but was free of immediate trees and obstructions along the Wrotham bearing.

The median value of the signal at the fixed site was 0·5 dB above normal with rapid fading superimposed on a slow fading component.

There was very little similarity between the signal patterns of the fixed and mobile recordings, the mobile site signal pattern varying at a slower rate.

Site 31. Pontop Pike—distance from fixed site approximately 10 miles (16 km). Height above sea level 960 ft (292 m). Ground profile towards Wrotham—Fig. 3.

This site was the highest tested during the Newcastle measurements; it was free from trees and obstructions along the Wrotham bearing.

The median value of the signal at the fixed site was 2 dB below normal with very rapid fading on a more slowly varying component.

There was a general similarity in the signal patterns of the fixed and mobile recordings.

The results of these measurements are given in Table 3.

4. RESULTS, GENERAL.

In this report the term median (time) expresses the field strength value exceeded for 50% of the time period during which measurements were made. Similarly, median (site) expresses the field strength exceeded at 50% of a number of locations, the distance between these locations being small compared with the path distance from the transmitter.

In Tables 1, 2 and 3 the seventh column indicates the degree of deviation of the median value (time) at any one of the selected sites from the median value (time) at the fixed site. If we assume that the various sites in the locality of the fixed site adequately "sample" all types of site and local terrain in the area, it is possible, by a statistical process, to determine by what degree the median value at the fixed site is representative of the median (site) conditions over the whole area.

This process has been applied to the results tabled for the three areas and Table 4 shows the results.

TABLE 3

RESULTS OF MEASUREMENTS MADE AT NEWCASTLE

For Ground Profile—See Fig. 3

Site No.	Location of Site	Distance from Fixed Site		Height a.s.l.		Site Details	Ratio in dB of Median Signal Level at Fixed Site relative to Normal* Median Level	Ratio in dB of Median Signal Level at Mobile Site to Median Level at Fixed Site	Ratio in dB of Q.P.** Signal Level at Mobile Site to Q.P. Level at Fixed Site	Comparison of Fixed and Mobile Records
		Miles	km	ft	m					
24	Heddon Laws	0	0	480	146	Within 50 ft (15·2 m) of fixed site aerial	+ 1	0	0	Identical. Fading period 0·1–0·5 minutes.
25	Throckley Colliery	2½	4	20	6·1	Lightly built-up	+ 5·5	– 9	– 12·5	Fixed site: fading period 0·2–0·5 minutes. Mobile site: different signal pattern. Evidence of long isolated bursts.
26	South Farm, Throckley	2	3·2	180	55	Rural	– 0·5	– 4·5	– 8	General similarity. Fading period 0·5–2 minutes. No individual correlation.
27	Worth Farm, Throckley	1½	2·4	300	91	Rural	+ 5	– 7·5	– 11	General similarity. Rapid fading on slow envelope.
28	Charlton Hill	1½	2·4	420	128	Rural	– 5	+ 2·5	0	Similarity in fading pattern. Rapid fading on slow envelope.
29	Bucks Nook Lane	5	8	625	190	Rural	– 3	– 1	– 3·5	Fixed site: fading rate 0·1–0·5 minutes. Mobile site: long isolated bursts. No similarity.
30	Goose Green	5	8	650	198	Rural	+ 0·5	– 5	– 9·5	Fixed site: fading period 0·1–0·5 minutes. Mobile site: fading period 0·1–1 minutes.
31	Pontop Pike	10	16	960	292	Rural	– 2	+ 1·5	+ 1	General similarity in signal patterns. Rapid fading on a slow envelope.

*Normal signal level refers to average median level measured at site during V.H.F. propagation measurements 1951–1952.

**Quasi-peak values—the value of the signal strength exceeded for 5% of the overall time of the observations.

TABLE 4

Area and name of fixed site	No. of sites investigated	Ratio of median value (time) at fixed site to median (site, time) for the whole area	Standard deviation of median (time) values
Nottingham, Dorket Head	13	+ 6 dB	9 dB
Harrogate, Pannal Ash	11	+3 dB	6 dB
Newcastle, Heddon Laws	8	+ 3 dB	4 dB

5. CONCLUSIONS.

Before drawing any rigid conclusions, it must be realised that these tests were conducted for a very short time when compared with the measurement periods usually associated with v.h.f. long distance recordings. Bearing these limitations in mind, the results indicate the following features:

a. The fixed site median (time) values tend to be higher than the corresponding median (site, time) for the whole of the area. This is no doubt because clear, open sites, rather higher than the average terrain in the area, were chosen for the long period recording of the Wrotham signals and these tend to be above average.

b. The decreasing value of the standard deviation at increasing distance suggests that height gain due to site altitude is of decreasing importance as the distance increases. By reciprocity, this conclusion agrees with the known effect that the height of the transmitting aerial is of relative unimportance in determining the field at great distances.

c. Comparison of columns 7 and 8 in Tables 1, 2 and 3 shows that, within a few decibels in general, the quasi-peak (Q.P.) values have the same relationship between the mobile and fixed sites as do the median values.

d. The slow amplitude fades are in general correlated in time at the various sites but there is no correlation between the amplitudes of the signals when fast fading is present or is superimposed upon a slowly fading signal.

e. From the results in the Nottingham area, it is concluded that the strength of distant v.h.f. signals in built-up areas is much lower than in areas free from obstruction. Complex fading patterns result from multiple reflections off nearby buildings and greater attenuation of field is apparent.